

TITLE OF INVENTION

PLASMA DISPLAY PANEL

CLAIM OF PRIORITY

[0001] This application claims the priority of Korean Patent Application No. 2002-68084, filed on November 5, 2002, in the Korean Intellectual Property Office, the disclosure of which is incorporated herein in its entirety by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0002] The present invention relates to a plasma display panel, and more particularly, to a plasma display panel with an improved design for dummy ribs.

2. Description of the Related Art

[0003] A plasma display panel displays an image on a screen using light emitted when a fluorescent material or a special gas is excited. A plasma display panel is roughly classified into three groups: AC type, DC type, and hybrid type.

[0004] In a display area of a plasma display panel, barrier ribs are formed on a lower substrate in the display area before being attached to the upper substrate. Outside the display area, additional ribs, called dummy ribs may also be formed. Dummy ribs are formed to maintain distance between the upper and the lower substrate during the process of making the plasma display panel.

1 **[0005]** Often, the dummy ribs are formed in sets containing 3 or 4 ribs in parallel with each other.
2 Japanese Patent Laid-Open Publication No. 2001-160360 discloses in FIG. 2 an AC type plasma
3 display panel having a plurality of dummy ribs 11 outside a display region to reduce abnormal
4 discharge. However, the design of dummy ribs 11 in FIG. 2 of JP 2001-160360 cannot withstand
5 sandblasting. Sandblasting can cause one or more of the dummy ribs 11 to fail. When one or more
6 dummy ribs 11 fail, the failed dummy ribs do not well serve to maintain proper distance between the
7 upper and the lower substrates.

8 **SUMMARY OF THE INVENTION**

9 **[0006]** It is therefore an object of the present invention to provide an improved design for dummy
10 ribs in a plasma display panel.

11 **[0007]** It is also an object of the present invention to provide a design for dummy ribs in a plasma
12 display panel that can maintain structural strength even after sandblasting.

13 **[0008]** It is further an object of the present invention to provide a design for dummy ribs in a plasma
14 display panel that can function to maintain proper distance between the upper and the lower
15 substrates even after a being subjected to sandblasting.

16 **[0009]** These and other objects can be achieved by a plasma display panel having upper and lower
17 substrates which are installed to be spaced apart from each other by a predetermined distance. The
18 plasma display device has a display region for displaying images and has portions outside the display
19 region. Within the display region are a plurality of barrier ribs with discharge spaces between
20 adjacent barrier ribs. Outside the display region are sets of dummy ribs, each containing several

1 dummy ribs in parallel to each other and spaced apart from the display region. The dummy ribs
2 serve to keep the upper and the lower substrates separated by a predetermined distance. Each set of
3 dummy ribs preferably has at least one reinforcing dummy rib. When the plasma display panel is
4 subjected to stress, the reinforcing rib is so designed to remain intact so that the reinforcing rib still
5 serves to maintain the space between the upper and lower substrates. The upper and the lower
6 substrates are sealed together by a sealant for sealing the edges of the upper and lower substrates.

7 **[0010]** The reinforcing rib may be formed of a series of closed ring structures with a cross-section
8 of a predetermined shape. The closed ring structures may have a polygonal or circular cross-section.
9 The dummy ribs may be formed in sets at each of the four ends of the substrate. Each set may have
10 up to three or more parallel dummy ribs on each side of the display portion. Each set of dummy ribs
11 may have at least one reinforcing rib. It is preferred that the reinforcing rib is closer to the display
12 region than other dummy ribs in the set. The dummy ribs may instead have at least one connecting
13 rib for connecting neighboring dummy ribs within a set to each other. The dummy ribs may instead
14 have at least one reinforcing rib with multiple bending portions.

15 **BRIEF DESCRIPTION OF THE DRAWINGS**

16 **[0011]** A more complete appreciation of the invention, and many of the attendant advantages thereof,
17 will be readily apparent as the same becomes better understood by reference to the following detailed
18 description when considered in conjunction with the accompanying drawings in which like reference
19 symbols indicate the same or similar components, wherein:

20 **[0012]** FIG. 1 is an exploded perspective view of a plasma display panel;

1 **[0013]** FIG. 2 is a perspective view of the plasma display panel illustrated in FIG. 1;

2 **[0014]** FIG. 3 is a perspective view of the structure of a plasma display panel according to a first
3 embodiment of the present invention;

4 **[0015]** FIG. 4 is a perspective view of the structure of a plasma display panel according to a second
5 embodiment of the present invention;

6 **[0016]** FIG. 5 is a perspective view of the structure of a plasma display panel according to a third
7 embodiment of the present invention;

8 **[0017]** FIG. 6 is a perspective view of the structure of a plasma display panel according to a fourth
9 embodiment of the present invention;

10 **[0018]** FIG. 7 is a perspective view of the structure of a plasma display panel according to a fifth
11 embodiment of the present invention;

12 **[0019]** FIG. 8 is a perspective view of the structure of a plasma display panel according to a sixth
13 embodiment of the present invention;

14 **[0020]** FIG. 9 is a perspective view of the structure of a plasma display panel according to a seventh
15 embodiment of the present invention;

16 **[0021]** FIG. 10 is a perspective view of the structure of a plasma display panel according to an eighth
17 embodiment of the present invention;

18 **[0022]** FIG. 11 is a perspective view of the structure of a plasma display panel according to a ninth
19 embodiment of the present invention; and

20 **[0023]** FIG. 12 is a perspective view of the structure of a plasma display panel according to a tenth
21 embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0024] Turning to the figures, FIG. 1 illustrates one example of an AC type plasma display panel 100. Referring to FIG. 1, the plasma display panel 100 is made up of a lower substrate 10 that has an address electrode 11, a lower dielectric layer 12, and a barrier rib 13 which are sequentially formed on the lower substrate 10. The barrier rib 13 serves to maintain a discharge space and prevent electric or optical cross-talk among cells. The barrier rib 13 can be made to have a stripe-shaped or a lattice-shaped pattern. The plasma display panel 100 also includes an upper substrate 18, which is coupled with the lower substrate 10. A patterned electrode pair 14 and 15, an upper dielectric layer 16, and an MgO film 17 are sequentially formed on the upper substrate 18. The electrode pair 14 and 15 are both orthogonal to the address electrode 11 and are embedded in the upper dielectric layer 16. A fluorescent layer is formed at one or more sides of a discharge space partitioned by the barrier rib 13.

[0025] In a plasma display panel 100 having the aforementioned elements, when a predetermined voltage is applied to each electrode, cations accumulate in the lower dielectric layer 12. The accumulated cations induce a preliminary trigger discharge between one electrode of the electrode pair 14 and 15 and the lower address electrode 11, thereby forming charged particles. As a result, a main discharge takes place between the electrode pair 14 and 15. Any light generated during the main discharge excites the fluorescent layer to thereby form an image.

[0026] An image forming area is designated as an effective area (22 in FIG. 2) and a central inner portion of the two substrates that forms the effective area is designated as a display region (22a in FIG. 2).

1 [0027] Turning to FIG. 2, FIG. 2 illustrates a perspective view of the plasma display panel 100 of
2 FIG. 1 after the upper substrate 18 is bonded to the lower substrate 10. When the upper and lower
3 substrates 18 and 10 respectively are formed as mentioned above, the two substrates are bonded
4 together with a sealing glass or other sealant 21 as illustrated in FIG. 2. The sealing glass 21 is
5 sintered and dried. Then, the inside of the two substrates is filled with a discharge gas and the two
6 substrates are completely sealed together. This completes the formation of plasma display panel 100.

7 [0028] The plasma display panel of FIG. 2 also has dummy ribs 23, which are formed between the
8 display area or the effective area 22 and the sealing glass 21. The dummy ribs 23 are used as support
9 members when the upper and lower substrates 18 and 10 respectively are clipped to each other
10 during the sealing process during the making of the plasma display panel. In addition, the dummy
11 ribs 23 serve to prevent a binder and other substances that are contained in the sealing glass from
12 flowing into the display region 22.

13 [0029] Such dummy ribs 23 are intended to prevent bending of the upper and lower substrates 18
14 and 10 respectively during the clipping process and also to prevent contamination of the inside of
15 the upper and lower substrates 18 and 10 by outgassing from a frit glass. However, such dummy ribs
16 23 may be damaged during a sand blasting process because closed type ribs experience an
17 approximately 12 to 13% higher abrasive sand blasting pressure than open type ribs. In addition,
18 because such dummy ribs 23 are formed in sets of three or four line patterns having the same
19 distance, the turbulence of an abrasive sand may occur between the display region 22 and the dummy
20 ribs 23. As a result, a dummy rib adjacent to the display region 22 may be damaged by abrasion.
21 Consequently, whole dummy ribs may not be able to withstand the pressure of the upper substrate

1 18 and thus fail to maintain the proper space between the upper and lower substrates 18 and 10 after
2 being exposed to sandblasting.

3 **[0030]** FIG. 3 illustrates a perspective view of the structure of a plasma display panel 30 according
4 to a first embodiment of the present invention. Referring to FIG. 3, plasma display panel 30 is made
5 up of upper and lower substrates 31 and 32 which are installed to be spaced apart from each other
6 by a predetermined distance and which contain therebetween a plurality of barrier ribs 13 and
7 discharge spaces 19 that are between adjacent barrier ribs 13. The barrier ribs 13 are located only
8 within display region 22a that displays images by the discharge spaces. A plurality of sets of
9 dummy ribs 34 are located outside display region 22a. Each dummy rib in a set 34 is parallel with
10 the other dummy ribs in that same set. Display 30 illustrates four sets of dummy ribs 34, one on each
11 side of the display region 22a. The sets of dummy ribs 34 serve to keep the upper and lower
12 substrates 31 and 32 separated by a predetermined distance. At least one of the plurality of dummy
13 ribs in a set 34 is a reinforcing rib 34a. Reinforcing rib 34a is designed to withstand damage caused
14 by sandblasting while still being able to function by keeping the upper and the lower substrates 31
15 and 32 separated by the predetermined distance. Plasma display panel 30 also is made up of a
16 sealant 21 for sealing the edges of the upper and lower substrates 31 and 32.

17 **[0031]** As illustrated in FIG. 3, each set of dummy ribs 34 has three ribs parallel to each other and
18 disposed outside of the display region 22a. Alternatively, the dummy rib sets 34 may contain four
19 or more ribs per set. Preferably, the rib in each set that is closest to the display region 22a is the
20 reinforcing rib 34a. The reinforcing rib 34a is preferably a series of ring holders (or ribs forming a
21 closed pattern) with a pentagonal cross-section, while the other two ribs 34b in the set 34 are simple

1 long rectangular walls. Because of the shape and design of reinforcing rib 34a, even if some parts
2 of the reinforcing rib 34a adjacent to the display region 22a are abraded during a sand blasting
3 process, the structural strength of the reinforcing rib 34a can be maintained by its pentagonal parts.
4 At the same time, the reinforcing rib 34a serves to prevent damage to the other two dummy ribs 34b
5 during sand blasting.

6 **[0032]** FIG. 4 illustrates a perspective view of the structure of a plasma display panel 40 according
7 to a second embodiment of the present invention. Referring to FIG. 4, plasma display panel 40 is
8 made up of upper and lower substrates 41 and 42 which are installed to be spaced apart from each
9 other by a predetermined distance. Display region 22a is used to display the images. Within the
10 display region 22a are the plurality of barrier ribs 13 and discharge spaces 19 that are disposed
11 between adjacent barrier ribs 13. Outside of the display region 22a are up to four sets of dummy ribs
12 44. As illustrated in FIG. 4, each set of dummy ribs 44 has three ribs, all being parallel to each other.
13 The middle rib within each set is a linear, rectangular rib 44b. On each side of rib 44b are the
14 reinforcing ribs 44a. The plasma display panel 40 according to the second embodiment differs from
15 the plasma display panel 30 of the first embodiment in that two reinforcing ribs 44a are present in
16 each set 44 instead of one. As in the first embodiment, the dummy rib sets 44 are spaced apart from
17 the display region 22a, reinforcing ribs 44a serve to maintain the upper substrate 41 to be a
18 predetermined distance from the lower substrate 42, even if the reinforcing ribs are damaged. A
19 sealant 21 is used to fasten the upper substrate to the lower substrate.

20 **[0033]** As illustrated in FIG. 4, each set of dummy ribs 44 has three ribs in parallel. However, it is
21 possible to have four or more ribs in each set. Two ribs that are positioned closest to and farthest

1 from the display region 22a are the reinforcing ribs 44a. A simple long rectangular rib 44b is
2 positioned between the two reinforcing ribs 44a. Each of the reinforcing ribs 44a is made up of a
3 series of ring holders with a pentagonal cross-section, as in the first embodiment. Because of this
4 structural advantage, even if some parts of the reinforcing rib 44a adjacent to the display region 22a
5 are abraded due to severe sand blasting, the space between the two substrates 41 and 42 can be
6 maintained as reinforcing ribs 44a can still function to keep substrates 41 and 42 separated by the
7 predetermined distance.

8 **[0034]** FIG. 5 illustrates a perspective view of the structure of a plasma display panel 50 according
9 to a third embodiment of the present invention. Like the above-described embodiments of the
10 present invention, the plasma display panel 50 has an upper and a lower substrates 51, 52
11 respectively sealed together by a sealant 21. Plasma display panel 50 has a display region 22a for
12 displaying images and a plurality of sets dummy ribs 54 which are located outside the display region
13 22a and are spaced away from the display region 22a by a predetermined distance. Each dummy rib
14 in each set 54 is parallel to each other. Each set of dummy ribs 54 serves to hold the upper and the
15 lower substrates 51, 52 apart by a predetermined distance. At least one of the ribs in each set 54 is
16 a reinforcement rib 54a. FIG. 5 illustrates one reinforcement rib 54a per set 54, the reinforcement
17 rib 54a being closest to the display region 22a.

18 **[0035]** As illustrated in FIG. 5, each dummy rib set 54 has three dummy ribs in parallel. Although
19 three are illustrated, this invention is not limited thereto and four or more ribs can be in each set if
20 so desired. One rib that is positioned closest to the display region 22a is the reinforcing rib 54a. The
21 reinforcing rib 54a is a series of ring holders with a square cross-section, while the other two ribs 54b

are simple long rectangular walls. In other words, reinforcing rib 54a is a line of squares raised off the lower substrate 52. Each square is similar to a section of a hollow tube having a square cross section. Because of this structural advantage of reinforcing rib 54a, even if some parts of the reinforcing rib 54a adjacent to the display region 22a are abraded during a sand blasting process, the structural strength of the reinforcing rib 54a can be maintained by its square parts. At the same time, the reinforcing rib 54a serves to prevent damage to the other two ribs 54b.

[0036] FIG. 6 illustrates a perspective view of the structure of a plasma display panel 60 according to a fourth embodiment of the present invention. Like the above described embodiments of the present invention, a plasma display panel 60 has upper and lower substrates 61 and 62 bound together by sealant 21. The display panel 60 has a display region 22a at a center and a plurality of sets of dummy ribs 64 spaced by a predetermined distance from the display region 22a. As in the other embodiments, the sets of dummy ribs 64 are used to hold the upper substrate 61 a predetermined distance from the lower substrate 62. As illustrated in FIG. 6, each set 64 has two reinforcing ribs 64a and one standard rib 64b. The standard rib 64b is in between the reinforcing ribs 64a.

[0037] As illustrated in FIG. 6, each set of dummy ribs 64 has three dummy ribs in parallel. However, this invention is not limited to three as there may be four or more dummy ribs in each set 64. Two ribs that are positioned closest to and farthest from the display region 22a are the reinforcing ribs 64a. A simple long rectangular rib (or standard dummy rib) 64b is positioned between the two reinforcing ribs 64a. Each of the reinforcing ribs 64a is a series of ring holders with a square cross-section as in the reinforcing ribs 54a of the third embodiment. Because of this

1 structural advantage of reinforcing ribs 64a, even if some parts of the reinforcing rib 64a adjacent
2 to the display region 22a are abraded due to severe sand blasting, the space between the two
3 substrates 61 and 62 can be maintained as the reinforcing ribs 64a can continue to function as
4 spacers.

5 **[0038]** Long rectangular dummy ribs may cause various problems when damaged. In contrast to
6 such dummy ribs, because the dummy ribs of the present invention have reinforcing ribs, each of
7 which is a series of closed structures or closed ring holders with a cross-section of a predetermined
8 shape, the dummy ribs can withstand with the pressure of the upper substrate even when damaged.

9 **[0039]** According to other embodiments of the present invention, the reinforcing ribs may have
10 circular or other polygonal cross-sections, i.e., hexagonal or lozenge (diamond)-shaped
11 cross-sections. FIGS. 7 and 8 illustrate the structures of plasma display panels 70 and 80 having
12 reinforcing ribs 74a and 84a with lozenge-shaped or diamond-shaped cross-sections. Elements of
13 plasma display panels 70 and 80 other than the reinforcing ribs 74a and 84a are the same as in the
14 first four embodiments. The shapes of the cross-sections of ring holders can be selected by
15 considering the easiness to manufacture and the pressure the upper substrate has on the lower
16 substrate of the plasma display panel.

17 **[0040]** FIG. 9 illustrates a seventh embodiment of the present invention. As illustrated in FIG. 9,
18 each set of dummy ribs 94 have two ribs in parallel. Each rib has straight or reinforcing portions 94a
19 and bent portions 94d disposed between straight portions 94a. Each dummy rib 94 is a series of
20 straight reinforcing portions 94a and bent portions 94d. As in the other embodiments, FIG. 9
21 illustrates four sets of dummy ribs 94, one on each side of the display portion 22a. Although two

1 ribs are illustrated in each set, the present invention can contain three or more ribs in a set.

2 **[0041]** Turning to FIG. 10, FIG. 10 illustrates dummy rib sets 104 according to an eighth
3 embodiment of the present invention. Dummy ribs 104 according to the eighth embodiment of the
4 present invention as illustrated in FIG. 10 further comprise at least one connecting rib 104c for
5 connecting neighboring ribs 104b to each other. Although FIG. 10 illustrates three ribs 104b in each
6 set, fewer or more ribs per set can be contemplated.

7 **[0042]** FIG. 11 illustrates a ninth embodiment of the present invention. In FIG. 11, dummy rib sets
8 114 are made up of a series of two closed reinforcing ribs 114a with a hexagonal cross-section and
9 multiple connecting ribs 114c for connecting the two reinforcing ribs 114a to each other. It is to be
10 appreciated that more than two rows can be used and that the reinforcing ribs may have other cross
11 sections besides hexagonal.

12 **[0043]** FIG. 12 illustrates a tenth embodiment of the present invention. Dummy rib sets 124
13 according to this embodiment have two reinforcing ribs 124a, one of which is positioned closest to
14 a display region 123 and the other is positioned farthest from the display region 123. Unlike the
15 fourth embodiment of FIG. 6, this tenth embodiment has each of the reinforcing ribs 124a having
16 open ends 124d. Such an open-type structure of both ends is applicable to the above described
17 various types of reinforcing ribs.

18 **[0044]** The dummy ribs may be formed on any one of an upper substrate or a lower substrate.
19 Preferably, each dummy rib is formed as thin as possible while maintaining sufficient strength to
20 support upper and lower substrates. The thickness of each dummy rib can be adjusted depending
21 on the dimensions of the substrates and the shapes of the cross-sections of the reinforcing ribs. The

1 material and fabrication method of dummy ribs can be applied to the present invention.

2 **[0045]** As apparent from the above description, because a plasma display panel of the present
3 invention has dummy ribs with a reinforcing rib, damage to the dummy ribs caused by sand blasting
4 is insignificant.

5 **[0046]** Furthermore, dummy ribs of a plasma display panel of the present invention have improved
6 resistance to abrasion by an abrasive sand. Therefore, even if some parts of the dummy ribs are
7 damaged due to the turbulence of the abrasive sand, the plasma display panel can function normally.

8 **[0047]** While the present invention has been particularly illustrated and described with reference to
9 exemplary embodiments thereof, it will be understood by those of ordinary skill in the art that
10 various changes in form and details may be made therein without departing from the spirit and scope
11 of the present invention as defined by the following claims.